DOCUMENT RESUME

ED 221 145 HE 015 505

AUTHOR	Parler, Nettie P.
TITLE	Improving Minority Students' Competencies: Strategies in Selected Colleges.
INSTITUTION	Southern Regional Education Board, Atlanta, Ga.
PUB DATE	82
NOTE	88p.
AVAILABLE FROM	Southern Regional Education Board, 1340 Spring Street, N.W., Atlanta, GA 30309 ($3.50).
EDRS PRICE	MF01/PC04 Plus Postage.
DESCRIPTORS	Ancillary School Services; *Articulation (Education); *Basic Skills; *Black Colleges; Black Students; College Instruction; College School Cooperation; College Students; Communication Skills; *Curriculum Development; Higher Education; High School Students; Learning Laboratories; Mathematics; *Minority Groups; Outreach Programs; Science Education; Secondary School Teachers; Student Personnel Services; *Teaching Methods; Tutorial Programs
IDENTIFIERS	Benedict College SC; Dillard University LA; Florida A and M University; Jackson State University MS; North Carolina Central University; *Piagetian Tasks; Project SOAR; Tuskegee Institute AL; *United States (South); Virginia Union University; Xavier University of Louisiana

ABSTRACT

Techniques designed to improve basic competencies of minority students attending selected, historically black colleges are reviewed. The efforts to improve instruction in targeted subject areas have been implemented with the assistance of the Southern Regional Education Board. Attention is directed to: modification of curricula and instructional techniques, particularly at the freshman and sophomore levels; learning centers; outreach to high school students and teachers; and institutionwide support services. Curricular modifications in the natural sciences and mathematics are described for the following schools: Xavier University in Louisiana, North Carolina Central University, Tuskegee Institute in Alabama, and Jackson State University in Mississippi. Efforts to improve communication skills of students undertaken by Florida A&M University and Virginia Union University are described, as are Piagetian-based instructional techniques at Xavier University (Project SOAR in Chemistry) and North Carolina Central University (Physics Projects). In addition to modified offerings, new courses have been developed: Literature of Science Course (Jackson State) and Scientific Instrumentation (North Carolina Central). A number of the colleges have implemented learning centers, which range from those that provide tutorial services to those that utilize sophisticated equipment and techniques. In addition, viable outreach projects implemented by the schools include: campus tours, mathematics/science Olympiad competition, programs for high school teachers, and summer programs for high school students. It is concluded that programs for improving student competencies and student retention will not be effective without strong support services reflecting institutionwide cooperation. (SW)

ED221145

IMPROVING MINORITY STUDENTS' COMPETENCIES:

STRATEGIES IN SELECTED COLLEGES

U.S. DEPARTMENT OF EDUCATION
NATIONAL INSTITUTE OF EDUCATION
EDUCATIONAL RESOURCES INFORMATION CENTER (ERIC)

☐ This document has been reproduced as received from the person or organization originating it.

☐ Minor changes have been made to improve reproduction quality.

• Points of view or opinions stated in this document do not necessarily represent official NIE position or policy.

Nettie P. Parler

"PERMISSION TO REPRODUCE THIS MATERIAL HAS BEEN GRANTED BY

SREB

TO THE EDUCATIONAL RESOURCES INFORMATION CENTER (ERIC)."

Southern Regional Education Board
1340 Spring Street, N.W.
Atlanta, Georgia 30309
1982
$3.50

HE 015 505

TABLE OF CONTENTS

Foreword. iii

Acknowledgments. iv

Introduction. 1

Modification of Curricula and Instructional Techniques. 3

Natural Sciences and Mathematics. 4

Communication Skills. 20

Piagetian-Based Instructional Techniques. 28

New Courses. 35

Learning Centers. 40

Outreach to High School Students and Teachers. 55

Campus Tours. 56

Mathematics/Science Olympiad. 57

Programs for High School Teachers. 58

Summer Programs for High School Students. 60

Institution-wide Support Services. 73

Conclusion. 78

Bibliography. 82

FOREWORD

For a number of years the Southern Regional Education Board (SREB) has worked with a group of historically black colleges and universities in the development of special procedures for the improvement of competencies of their entering students. The outcomes of these efforts are significant, and will be of interest on other campuses where similar concerns are receiving attention. The techniques which were developed differ in many respects from traditional remedial efforts, and most of them include outreach dimensions to the public schools, a procedure which has been neglected in the past but deserves priority in the future.

Most of the special activities described in this report were developed as part of a program for the improvement of instruction in selected black colleges and universities supported with funds from the William R. Kenan Jr. Charitable Trust.

Dr. Nettie P. Parler, the principal writer of this report, spent considerable time reviewing the detailed reports of these special programs and visited many of the campuses to observe their operation. Her long experience at South Carolina State College and her previous work with SREB activities provided a strong background for this assignment.

William C. Brown, Director
Institute for Higher
Educational Opportunity
Southern Regional Education
Board

ACKNOWLEDGMENTS

This document is, by its nature, eclectic. It could not have been written without the contributions of the directors and other faculty members who are implementing the special programs at the colleges and universities of this study. I am deeply indebted to them. They gave me so much of their time and attention when I visited their campuses to discuss their programs and to gather pertinent data.

I also want to express my sincere thanks to the many students with whom I talked as I visited the various institutions and their special programs. They were generally well-informed and their comments were illuminating and helpful.

I owe a heavy debt of gratitude to two members of the staff of the Southern Regional Education Board's Institute for Higher Educational Opportunity. I sincerely thank Dr. James M. Godard and Dr. William C. Brown for their generous help and must make clear that any error or infelicity that remains in the document is entirely my fault--not theirs.

Nettie P. Parler

INTRODUCTION

Specially designed programs for improving basic competencies among entering college students have existed for decades. Fifty years ago, Ohio State University was pioneering in remediation of reading skills. And Duke University was requiring freshmen in the lowest fifth of the American Council Psychological Examination to take a three-hour course in the Psychology of Study Habits, a course which produced significant statistical results in grade-point averages. The problems today are even more complex. A larger percentage of high school graduates attend college, many of whom are deficient in reading, language, and mathematical skills. These factors are among the recognized causes for poor retention of minority students, both in historically black and historically white institutions. They are also the reasons for the low proportion of black students selecting majors in mathematics and sciences and choosing science-related careers.

In a number of black colleges and universities, new approaches and resources have been developed far beyond the traditional "remediation" efforts of the past, which carried a stigma in the minds of many students who were required to take them. These new approaches are more sophisticated than routine drill and tutoring, and they are being perceived by students as an avenue of opportunity. These techniques are applicable to any institution, and, with modifications, to all levels of postsecondary education, from two-year institutions to graduate and professional schools.

For over 10 years, the Southern Regional Education Board (SREB) has assisted selected black colleges and universities in improving instruction

in targeted subject areas. These efforts, supported by grants from the William R. Kenan, Jr. Charitable Trust, have included programs which have addressed the development of basic competencies in a variety of ways. This publication draws substantially, although not exclusively, on experiences observed and evaluated in these projects.

The qualities characteristic of these approaches to improving competencies are critical. First, they were a result of institution-wide planning, even though a particular academic department may have had a major responsibility for execution. Second, most of them involved interdisciplinary dimensions. For example, mathematical skills were recognized as being dependent upon verbal skills. The ability of a student to move from concrete thinking to abstract thinking was recognized as a key ingredient in the mastery of all competencies. Finally, motivational factors were given a high priority as conditions essential to achievement of higher competency levels.

The report is divided into four sections: modification of curricula and instructional techniques, particularly at the freshman and sophomore levels; learning centers; outreach to high school students and teachers; and institution-wide support services. It will be observed, however, that such a division is, to a degree, artificial, since each type of project may be related to components in other categories; for example, the modification of instruction may be dependent upon the quality of learning centers.

MODIFICATION OF CURRICULA AND INSTRUCTIONAL TECHNIQUES

Since basic competencies for success in college are essential early in the student's college experience, a major effort is being made on a number of campuses to modify both the content and teaching resources of courses in certain targeted areas. The intent is to maintain respectable requirements for completion of the courses and also to assist educationally disadvantaged students to reach the expected level of performance.

As a rule, the freshman year is a time in which students select majors and make career choices. It is a critical period, especially for educationally disadvantaged students. They do not possess, upon college entrance, the knowledge and skills necessary for success in such fields as mathematics and sciences, in which many of them wish to specialize. And, many lack essential communication and verbal skills. There is a need, therefore, for "bridge" programs to maximize the chances that underprepared students will be able to overcome their deficiencies; and that those who desire to do so will be able to select such fields as mathematics and sciences for majors and careers. It is particularly important that emphasis in these programs be placed on improving problem-solving skills as well as learning subject matter.

The modified courses and instructional techniques of the programs described represent successful efforts of some historically black colleges

and universities to assist educationally disadvantaged students to overcome the marked deficiencies which they have upon college entrance, and, concomitantly, to provide them with standard courses at the college level. This is no mean task. The examples presented indicate what can be done in such critical areas as natural sciences, mathematics, and communication skills.

NATURAL SCIENCES AND MATHEMATICS

The curricular modications described here are designed to reduce the student attrition rate in natural sciences and mathematics, to increase the level of student performance in these areas, to increase the number of students majoring in mathematics and sciences, and to prepare science and mathematics majors for professional and graduate schools.

The Xavier Program. At one of the institutions of the study, Xavier University of Louisiana, faculty representatives of the departments of biology, chemistry, mathematics and computer science, and physics and pre-engineering spent an average of five hours per week during the planning period of their Kenan project (1976-77). They audited each other's courses, developed materials for the summer program, and planned for modifications in introductory-level courses to provide more support for the underprepared student. It became apparent to the planners that the much-needed course modifications could not be accomplished with Kenan funds alone. Fortunately, efforts to secure additional support were successful: in the fall of 1977, Xavier became the first historically black institution to receive funds from the National Science Foundation's CAUSE (Comprehensive Assistance to Undergraduate Science Education) program. Thus, the Kenan funds and the CAUSE

grant provided the comprehensive support needed by the institution to effect change in curricular and instructional techniques in mathematics and sciences in a meaningful manner. A brief discussion of the changes effected and the results of these changes follows.

All majors in biology, psychology, medical technology, pre-pharmacy, and pre-medicine/pre-dentistry at this institution are required to take a year-long entry-level biology course for science majors. There are no prerequisites for enrollment in the course, and no placement examinations are given. All departments, however, require that their students make a grade of "C" or better in the course. The entry-level biology course was modified significantly. It was changed from one semester of general biology and one semester of zoology to two semesters of general biology. Materials for the new course were developed and field-tested. The development and use of the special materials led to a significant reduction in attrition in the entry-level biology course and outstanding progress in the performance of the students. For example, in 1979 and 1980, following the implementation of the modified biology sequence, the percentage of students completing the "off-semester" portion (i. e., in the spring rather than in the fall) increased dramatically from approximately 25 percent to more than 50 percent. This is quite significant, since "off-semester" sections have higher percentages of entering students with known academic deficiencies and correspondingly lower chance of completing the degree program in the sciences. Therefore, the course modification is particularly noteworthy for the academically disadvantaged, the group for whom the development was aimed.

In regard to the level of performance of the students in general, the percentile rank of the average score on a standardized test in general biology, administered in 1979 and 1980 to random samplings of students upon their completion of the modified biology course, more than doubled what it was before the course modification.

Carmichael, Ryan, and Whimbey made the following statement in regard to general chemistry in a published article titled "Cognitive Skills Oriented PSI in General Chemistry":

> One of the major problems facing college-level science faculty is how to increase access to science-related career courses for the educationally disadvantaged without sacrificing quality education. This problem is especially acute in entry-level courses. The most common solution has been to develop "prep" courses that precede the entry-level ones which are then taught in the traditional manner. An alternative approach is to modify teaching techniques in entry-level courses so that both the well-prepared and the educationally disadvantaged have a reasonable chance of success. The latter has been used at Xavier University of Louisiana, a small predominantly black institution in New Orleans, to develop a general chemistry sequence for science majors which has proven effective as measured by standardized testing and student response.
>
> The general chemistry sequence at Xavier is conducted in a modified PSI (Personalized System of Instruction) format. The modifications are based on research at Xavier and other institutions. . . that have identified both the strengths of PSI for educationally disadvantaged students and also special problems such students are likely to encounter with PSI.[1]

---

[1] J. W. Carmichael, Jr., Mary A. Ryan, and Arthur Whimbey, "Cognitive Skills Oriented PSI in General Chemistry," Journal of Developmental and Remedial Education 3 (Winter 1979): 4.

The modified general chemistry course at Xavier is a two-semester sequence with separate lecture and laboratory sessions. It consists of two one-hour lectures per week, one 3-hour cognitive therapy-oriented drill session per week, one 3-hour Piagetian-based laboratory per week, and approximately 20 hours per week of tutorial service by a staff person. The core of the course is a handbook[2] written by three faculty members. The handbook is composed of a series of lecture/text modules which contain objectives, assignments in the textbook, sample problems, and other learning activities. It makes it possible to provide the basic structure of PSI: namely, a series of limited, well-defined units. The student must master each unit before proceeding to the next. The handbook also furnishes the framework for a number of teaching strategies, such as the retention of lectures as an additional learning source for the educationally disadvantaged, weekly cognitive therapy-oriented drill sessions to teach both chemistry content and thinking skills, the review of mathematics to alleviate difficulties educationally disadvantaged students often experience in chemistry, the required use of molecular models, special devices designed to build self-confidence in students, final examinations which demand high-level performance but are repeatable, extensive out-of-class tutoring, and a Piagetian-based laboratory sequence.

As to student evaluation and performance, the following summary is significant.

---

[2]J. W. Carmichael, Jr., Mary A. Ryan, and JoAnne Bauer, General Chemistry Handbook (Champaign, Ill.: Stipes Publishing Co., 1980).

The decision to modify teaching techniques in the general chemistry sequence for science majors at Xavier in an effort to assist the educationally disadvantaged has been extremely successful.

1. The average performance of students completing general chemistry at the University has increased more than 20 percentile points on a standard measure of achievement, the American Chemical Society's Cooperative Examination in General Chemistry. Further, the average performance on this test is now above the national average (including opportunities to repeat with no review of tests)--a remarkable achievement, considering the average SAT/ACT scores of the students entering Xavier.

2. The percentage of students completing the two-semester sequence has increased from 50 percent before the modification to more than 65 percent at present.

3. Students in general chemistry have consistently rated the course highly in a university-wide course evaluation procedure. In addition, a departmentally-administered questionnaire indicated that 83 percent of the students liked general chemistry even though they felt they worked harder in the present course than they would have in a traditional course. The compensating factor was apparently the fact that they felt they also learned more than they would have in a traditional course.[3]

The university's philosophy of "standards with sympathy" is dramatically illustrated in a modified general chemistry sequence that couples high expectations with mechanisms that allow educationally disadvantaged students to succeed. Analytical reasoning is nurtured through the use of cognitive

---

[3] Carmichael, et al., "Cognitive Skills," p. 6.

therapy and Piagetian-based materials. (For a detailed discussion of the Piagetian method, see pp. 28-34.)

The modifications in the mathematics component of the Xavier project were focused upon improvement of the two courses taken by most science majors: pre-calculus and calculus I. The first course is a combination of elements from algebra and trigonometry; the second is both a terminal course for most science majors and the first semester of a three-semester sequence for a much smaller number of students.

The mathematics faculty studied the relationship between entry-level courses (pre-calculus and calculus I) and developmental mathematics courses, and made major modifications to make certain that they were complementary. The calculus I course, which is required for most science majors, was changed from merely the first semester of a three-semester sequence to a one-semester survey course with emphasis on skills.

An appreciable degree of progress has been made in reducing attrition and increasing the level of performance in the mathematics phase of the Xavier program. Since a science or math student whose grade is lower than "C" in an entry-level science or mathematics course is unlikely to successfully major in one of these areas, the percentage of students who complete the entry-level courses with the grade of "C" or better appears to be a suitable measure of retention. In this connection, it should be noted that the percentage of students completing the pre-calculus course in this program with a "C" or better grade increased from 36 percent (1977) to 57 percent (1979) during this three-year span.

Student enrollment in physics is lower in entry-level courses than in the other three components of the Xavier program. However, modifications were necessary because many students who enroll in the physics courses, although better prepared than those who enroll in the other entry-level courses, still have marked deficiencies, especially in problem-solving skills. Modified materials were developed and field-tested for the entry-level, two-semester sequence in 1977-1979. In the spring of 1979, a decision was made to reduce the number of credit hours for the physics sequence from eight to six. Therefore, additional modifications followed in the summer of 1979 and in the 1979-80 academic year to accommodate the change in credit hours without sacrificing the quality of the sequence. The data gathered during and after the change indicated that significant progress has been made in reducing attrition and increasing the level of performance in the entry-level physics courses.

Again, it is assumed that the percentage of students who complete the physics sequence with a grade of "C" or better seems to be an appropriate measure of the degree of retention. It is noteworthy that the percentage of students completing both semesters of physics with a grade of "C" or better increased from 53 percent (1977) to 73 percent (1979). The level of performance for the same period showed a 20 percent increase as measured by the final examination in the second semester of the sequence. Efforts to find a national standardized examination for a non-calculus-based physics course were unsuccessful; therefore, it was not possible for the physics faculty to compare the level of performance of the students

to a national norm. It is significant to note that changing the physics sequence from eight semester hours to six semester hours did not decrease the level of performance of the students in either half of the course.

The handbook which serves as the core of the entry-level chemistry courses was previously mentioned. Handbooks have also been developed (and published locally) for each of the other three areas of the Kenan project (biology, mathematics, and physics). These handbooks codify objectives, provide sample problems, contain sample tests, and provide extensive guidance to students. Laboratory manuals have been developed for the biology, chemistry, and physics areas. All of these manuals contain components of Piagetian-based "learning cycles" designed to promote general problem-solving ability. An entire sequence of such materials in chemistry has been developed and published.

The student enrollment in the four participating departments (biology, chemistry, mathematics, physics) increased from 138 in 1975-76, the academic year prior to the initiation of the Kenan project, to 464 in 1980-81. This phenomenal increase of 236 percent places Xavier among the top few institutions in the nation in the number of black students with declared majors in the sciences.

A unique feature of the Xavier program is the mechanism it provided for four departments to work across departmental lines, to exchange ideas, to evaluate the effectiveness of various techniques, and to implement similar activities. The program also provided a facility--the Alternate Pathways Learning Center--in which the four departments could offer special

support for the underprepared student. (For a description of this facility, see the section entitled "Learning Centers.")

The North Carolina Central Program. A major thrust of the Kenan project at North Carolina Central University (NCCU) was the development of a modified entry-level mathematics course for students majoring in the sciences. At the outset of the project, it was the consensus of the planners that the quality of science courses and the level of laboratories and research activities at upperclass levels at the university are limited by the students' lack of computational abilities, their lack of familiarity with the methods of applied mathematics, and, in general, their prejudice and reluctance toward the quantitative language of science. The fact that most of the students, in spite of prolonged exposure to math courses, were not acquiring the necessary skill and literacy convinced members of the faculty that an alternate path leading toward basic competence in mathematics had to be developed.

There was an obvious need for curricular changes which would lead the students to the level of calculus and beyond in dealing with more advanced topics of their disciplines during their junior and senior years. There was also a need for a new approach which would allow teachers to accomplish their goals of both emphasizing the applicability of calculus and upholding a certain standard of mathematic integrity. Therefore, in the fall of 1976, two members of the mathematics faculty began considering possible alterations of the mathematics curriculum that would be consonant with the aforementioned goals. As a result, a unique course was introduced which would be available to any student demonstrating a proficiency in algebra roughly equivalent to

intermediate algebra. The plan was to cover the absolutely essential notions from algebra and analytic geometry rather quickly and then to introduce an intuitive treatment of integration, differentiation, and the fundamental theorum of calculus. The textual materials adopted by the teachers for this informal study of calculus had already been prepared by Education Development Center, Incorporated, under the National Science Foundation-funded Project CALC (Computer and Laboratory Calculus). Three preliminary modules of these materials had been published in July 1974--one on differentiation, one on integration, and one on relating differentiation and integration. The modules had been tested in 30 schools with favorable reviews, and in July 1975 the second editions had appeared.

The next problem of the mathematics faculty was to bridge the gap between the highly intuitive, informal approach of the CALC treatment and the more formalized notion of calculus. The faculty had already agreed that the modified course would be a two-semester sequence and that it would carry five credit hours per semester. Upon completion of this sequence, any student who needed to pursue further study of calculus on a more rigorous basis would be expected to take the usual calculus sequence. Biology majors and some chemistry majors would not be required to take any further mathematics courses beyond the modified sequence. Hence, there was a need to include a great deal more than intuitive calculus and, at the same time, to continue the spirit of the CALC materials to some extent and in some form. To meet this need, a course outline for the modified program was prepared to include rules for differentiation, techniques of integration, calculus of transcendental functions, curve sketching, and ordinary differential equations.

By the spring of 1977, some interesting ideas and a reasonably promising alternative for many of the students had emerged. The alternative was a revised mathematics sequence designed to assist underprepared students in overcoming their mathematical difficulties. The sequence has been offered continuously since 1977. As a major thrust of the Kenan program, the mathematics project has produced an appreciable degree of success in moving students into calculus and differential equations.

Some noteworthy impressions as to the effect of the mathematics project were related by the director of the Kenan program at NCCU in a report to the Southern Regional Education Board. The report indicated that student grades were higher in both the first and second semester of the modified mathematics course than they had been in the traditional math course; class attendance was better; and general class "attitude" (as measured by willingness to participate in class discussions and other intangibles) was better. The students' test performances have reflected improved ability to work such "applications" problems as exponential growth and decay, center of mass, maximum-minimum, etc. The report also indicated that individual students have done very creditable work on special assignments in the course.

Interdepartmental relations have been significantly improved; mutual concern and helpfulness by the mathematics and science faculties became quite evident as the project evolved. This spirit of increased interdepartmental cooperation has also been very beneficial in the development of the second phase of the Kenan program at NCCU--computer-assisted instruction. For a discussion of the computer-assisted instruction project in the Mathematics Learning Center, see pp. 42-45.

Tuskegee Institute. The overall goal of the Kenan Science Project at Tuskegee Institute is not only to increase the number of students who choose to major in the basic sciences but also to increase the number of students who successfully complete the requirements for the Bachelor of Science degree in their chosen areas. Emphasis is placed on the disciplines of biology and chemistry.

The general plan for accomplishing the goal is two-fold: first, to reduce the rather high attrition rate of freshmen who enroll as declared majors in biology and chemistry and, thus, increase the number of students who will ultimately complete degree requirements in these areas; and secondly, to attract students who enroll initially as declared majors in non-science fields into biology and chemistry and, thus, to increase further the pool of potential candidates for degrees in these areas.

In implementing the two-fold plan, three innovative, entry-level courses have been introduced--two in biology and one in chemistry. The courses are not designed to replace traditional ones, but to provide adequate preparation for them. They are designed for the non-science major and also for the student who is inclined toward a science major but lacks the basic preparation for successful performance in the traditional science courses. It should be emphasized that the three entry-level courses initiated in this project are not remedial courses, but courses which focus upon a different population of entering students. The primary focus is on human biology and the interrelationships among chemistry, biology, and physics as scientific disciplines in the structure, function, evolution, and ecology of any organism.

Emphasis in the three courses is placed upon student motivation. To this end, special course materials are selected and innovative instructional methods are employed. With a view toward developing the inquiring mind, instructors encourage active and widespread student participation in discussion. The purpose is not only to provide basic preparation for college-level courses in biology and chemistry, but also to stimulate more interest in these sciences and in careers based upon them, and, finally, to enrich the general educational backgrounds of students regardless of vocational preference. In the process, a significant number of students have been attracted into the basic science areas and the allied health sciences as majors since the initiation of the Kenan science project in the 1977-78 academic year. The number of students graduating with the Bachelor of Science degree has steadily increased.

As a component of the science project, a Test and Examination Skills Development Program was launched in the first semester of the 1979-80 academic year. This program is an eight-week course offered in both the fall and spring semesters. It consists of concentrated instruction focusing on techniques to aid the students in building test-taking competencies. The course is organized around four instructional modules: Reading Comprehension, Analytical Thinking, Vocabulary Building, and Test-Taking Techniques.

Past experience has shown that mastery of the subject matter, particularly in the basic sciences, while extremely important, was not enough alone to insure that the students would perform well on the standard examinations for admission to graduate and professional schools and the standardized

examinations required for licensure by the numerous allied health professions certifying boards. The students must also have mastery of the testing techniques used in such examinations.

To further enhance the quality of instruction in the basic sciences at Tuskegee, the Kenan Science Center was developed. (See the section titled "Learning Centers" for a description of this Center.)

Jackson State University. The Kenan program at Jackson State University is devoted primarily to mathematics, with a major goal of generating a flow of more students to the upper level of this discipline so that mathematics requirements of various scientific areas can be met. The program also intends, as a direct by-product, to increase the number of science-oriented majors at the university.

During the 1970s, it became evident that each year more and more students were entering the university who could not exercise many of the basic computational skills. The initial phase of the Kenan program, therefore, included the development of an acceptable method of utilizing test scores and other pertinent information for placement of the entering students in the mathematics courses. Proper placement was essential. To achieve effective teaching and learning, the backgrounds of the students must parallel the contents of the prescribed courses. Therefore, in the fall of 1978, a placement plan was effected at the university which permitted the assignment of students to entry-level mathematics and algebra courses in accordance with their scores on a national standardized test and an examination prepared by faculty members. The personal interview was used as a final placement instrument in cases of doubt.

A list of competencies to be attained by the students in each introductory course was made. The content of each course was then modified in consonance with the particular competencies involved. The revised content of each course differs from the previous content in that it is geared more toward those students who enter the university needing extensive work in the basic arithmetical skills and/or the basic algebraic skills. Students are provided with copies of a glossary of mathematical terms with concrete models designed to increase the perception of mathematical concepts and ideas.

During the fall of 1980, with the aid of the Kenan grant, the Department of Mathematics embarked on its first venture in the use of self-paced, competency-based instruction as an optional method in the delivery of its educational services.

Although a large number of the students who enter the university are unable to exercise many of the basic mathematical skills, these students vary greatly as to which skills they lack. Because of the limited time available and because students should not waste time on skills they already have acquired, the mathematics faculty decided that something should be done to accommodate individual needs as much as possible. Thus, a plan for self-paced instruction in the basic skills of arithmetic was adopted. It was restricted to the first course in the mathematics curriculum--Basic Concepts of Mathematics (Math 101).

In the self-paced program, inventory tests are used to diagnose general difficulties. Following the inventory tests, the students work on modular exercises directed to development of needed skills, as determined by their test scores. The inventory tests are keyed to the exercises. The students

may take as many tests and complete as many exercises during a given period as time allows. If a student cannot follow the examples independently, he is given help by either the instructor or a student assistant from the Kenan Mathematics Laboratory. (This laboratory is described under the heading "Learning Centers.")

The students in the self-paced mathematics course are given the following instructions in a handout:

> The class is self-paced. This means that the work is up to you! You will be expected to learn by reading the assigned parts of the book and by working the problems. The class periods are to be used mainly for checking your assignments. The teacher will be in the classroom to help you, if you need help. There will be class periods designated for review, at which time the teacher will employ strategies designed to enhance the materials covered in the module. After the review, a test will be given on the materials covered in the module.
>
> Students must make the required score for each module in order to move to the next module. Any student needing to take a test over for a given module will do so at a time that will be designated on a make-up schedule.
>
> You must try very hard to pass the tests in the time frames given.
>
> Each module will have a set passing score. A student will have to obtain at least the passing score on each module and complete all modules to pass the course. For some people, this class offers too much freedom. It becomes too easy to let mathematics slide. No one will be "on your back" to do the work. It's all up to you. If you think this approach is not for you, then check with the instructor to see if you can transfer to a regular lecture class.[4]

---

[4]Course Description, "Basic Concepts in Mathematics--Math 101," Mimeographed handout, p. 1.

To evaluate the effectiveness of the self-paced instruction as compared to the usual method employed, a member of the mathematics faculty developed an objective measurement instrument. When this instrument was first administered to the aggregate self-paced group and two additional classes (taught by the lecture method), the following results were obtained:

	Mean Score
Self-paced Group	20.8
Standard Class I	18.375
Standard Class II	18.6

It should be noted that the students in the self-paced group scored 11.6 percent better than those in Standard Class I and 10.2 percent better than those in Standard Class II.

In addition, it is noteworthy that, in the spring semester of the same academic year, the results of a pre-test and a post-test administered to two sections of the self-paced class showed significant progress. The pre-test and post-test were equivalent forms supplied by the publishers of the textual materials.

	Pre-Test Mean Score	Post-Test Mean Score
Self-Paced Class I	14.625	20.125
Self-Paced Class II	13	21.75
Aggregate	14.08	20.67

These figures reflect a 37.61 percent increase for Class I, a 67.31 percent increase for Class II, and a 48.8 percent increase for the aggregate.

COMMUNICATION SKILLS

In the college student population in which weak academic backgrounds are evident, the most obvious need is for improvement in communication skills.

The minute the student speaks or writes, the listener or reader becomes aware of the strength or weakness of his or her communication skills. At the heart of college teaching and learning is the need for high levels of skill in reading, writing, speaking, and listening. In the 1970s, as a result of declining test scores and a general perception among the population that the schools were no longer providing students with adequate verbal skills, national concern was transformed into mounting demands for a return to basics and for the development of measurable basic competencies in students.

Minority students have always been woefully served by the dominant culture in the educational system; however, their plight during the current national literacy crisis has greatly worsened. Today, many of these educationally disadvantaged students enter college so poorly equipped verbally that they cannot write or speak in complete sentences or listen to the spoken word and/or read the written word with a reasonable degree of comprehension. College English departments are faced with the challenge of teaching these students basic communication skills while at the same time trying to maintain the integrity of college-level English courses.

Florida A&M University. One of the colleges, Florida Agricultural and Mechanical University, in recognition of the crucial need to improve student competencies in oral and written communication, developed an interdisciplinary program in reading, writing, and speech, with the aid of a Kenan grant administered by SREB.

The program began as a pilot course for some 60 students in the fall of 1973 and expanded, during the grant period, to a university-wide program

serving hundreds of students each year. The program is student-centered. The aim is to begin where the students are and permit them to proceed toward their goals at their own pace. There is great emphasis on transfers of learning from one academic area to another. The course in reading, speaking, and writing is offered in an interdisciplinary fashion five days a week for two successive quarters to students who are deficient in communication skills when they enter the university. (The traditional classes meet only three days per week.) The interdisciplinary course is team-taught, with each instructor assuming responsibility for his or her own specialty. The program's emphasis on the transfer of the three skills to other academic disciplines has influenced instruction in communication throughout the general education program at the university.

The curriculum materials for the course include modules predicated upon the interrelatedness of the three skills. These instructor-designed modules have been periodically revised as interactions of the teaching-learning process have indicated the efficacy of the changes. Analytic instruments have been used to evaluate student work in the course. Individualized instruction is provided through a writing laboratory and through open conference days on which the students are given opportunities to discuss their problems informally with their instructors.

This cooperative teaching project has resulted in the development of a considerable body of classroom-tested materials. The instructors have been challenged to investigate areas beyond their individual fields of specialization. Faced with the commitment to help each student at his or her

level of need, the instructors have constantly developed both materials and methodology with which to aid students requiring special instructional strategies.

The director's report evaluating the project at the end of the five-year Kenan grant period stated that two instruments had been used to measure the effectiveness of the interdisciplinary course: a student survey prepared by the staff and administered at the end of the sequence to test the affective domain and alternate forms of the McGraw-Hill Basic Skills Writing Test (used as a pre-test and post-test) to measure the cognitive domain. The report indicated that, by and large, the students gave this course a high rating. In the survey, the students reacted more positively than negatively to items pertinent to the interrelatedness of instruction, the classroom presentations, the operation of the laboratory, and the emphasis upon actual learning material. It should be noted that the major focus of the sequence is precisely upon these areas. A majority of the students showed positive improvement in post-test scores relative to pre-rest scores as measured by the McGraw-Hill Basic Skills Writing Test.

Virginia Union University. At another institution, Virginia Union University, a successful program in teaching communication skills through the various disciplines was developed.

The program is a concentrated effort to fulfill with increasing expertise the university's declaration of commitment ". . .good teaching and enlightened guidance were, and still are, the institution's primary concerns. That the student will develop the knowledge, skills, and attitudes for

enriching his own life and that of the community in which he will serve remains the generating force of the total academic endeavor." The communications skills program seeks to fulfill this goal by providing knowledge, upgrading skills, and laying the foundation for productive attitudes toward self and others through listening, speaking, reading, and writing.

In 1976, members of the English faculty began to search for more creative solutions to the problems in writing which seemed to exist from the entering freshman to the graduating senior. This general observation, along with statements they noted in some professional publications, led to their conviction that the student's writing skill would advance little without either parallel or prior attention to reading improvement. Their further probing, spurred by other discoveries, suggested the planning of oral/aural experiences as a diagnostic tool and as a means of structuring immediate, need-based teaching-learning activities. Further deliberation indicated the feasibility of using models of writing which have general readership appeal but which are easily subsumed under headings of social science, natural science, arts, and humanities. This was the genesis of ideas that culminated in the launching of an innovative program at Virginia Union titled "Teaching Communication Skills Through the Disciplines."

The program is predicated upon a unique videotaping design in the teaching of communication skills. Through videotaping, oral skills are developed in preparation for writing. The student is expected to demonstrate in his writing the knowledge derived from the oral reading experiences plus the classroom instruction, discussion, and analyses. Since the institution of

the videotaping instructional technique in 1976, thousands of student videotapes have been made, reviewed, and analyzed in a specially equipped video laboratory. The recording-listening booths in this laboratory are in constant use as the students record, play back, analyze, and evaluate their video performances to assess their progress in developing their communication skills. However, the final evaluation of each student's videotape production is made by the instructor in an individualized session with the student.

After discovering the effectiveness of enriched, structured, oral experiences as essential to the teaching of writing and the often dramatic gains weaker students make through such experiences, the planners decided to delay the writing activities in the pilot course and to focus attention intensely upon the various aspects of oral communication. They decided to teach the students first how to cope with the printed page phonetically, syntactically, semantically, analytically, and interpretively. Intensive instruction in writing was postponed until later in the semester when oral, in-depth experience had formed in the student's mind a seedbed for growth in writing competence. The Kenan Program planners were of the opinion that this strategy would lay a better foundation for reading and writing throughout the student's college career.

The pilot course, launched in the 1976-77 academic year, was successful. At the end of the year, the 100 students enrolled in the course performed only marginally better on a standardized basic writing skills test; but in the holistic essay evaluation, in the "best papers" category, they performed almost twice as well (40 percent vs. 22 percent) as the students

who enrolled in the traditional freshman composition program. In the second year, there was a substantial increase in the number of students placed in the special course, and a substantial increase in student scores on the standardized basic skills test as well as a phenomenal degree of improvement in student writing. Emphasis on orality as a diagnostic and developmental tool proved to be an invaluable component in the teaching-learning process in the communication skills area. Therefore, in the third year, it was decided that the procedures and techniques developed in the pilot course would be used to teach communication skills to all of the students in the freshman English composition sections and in the sophomore humanities sequence.

The modified program opened avenues of cooperation with the various disciplines beyond the traditional referral to the English department for the mechanics of term paper writing. The faculty and administrators participated in action research seminars, workshops, and conferences to become better acquainted with the importance of scientific research in improving instruction. They identified specific communication skills needed by the students. They recognized the need for scientific information to provide the basis for decision making and for the selection of effective activities in which students would learn and use language for increasing their competencies in general communication.

As a result, the students at the freshman and sophomore levels at Virginia Union now receive instruction continuously in both the receptive and expressive skills. In this connection, emphasis is placed on the following skills.

A. Receptive Language Skills

1. Listening--courteously, attentively, and critically.

2. Reading--comprehension, rate, word study, critical analysis, contextual clues, inferences, and relationships.

B. Expressive Language Skills

1. Oral Reading--articulation, pronunciation, prose rhythms, phrasal groupings, patterns, coherence, and cadence.

2. Speaking--group and person-to-person interaction.

3. Writing--clarity, coherence, and organization.

For individualized help with writing problems, students are referred to the Writing Resource Center. This learning center is staffed by a full-time instructor and several student assistants. The classroom teachers and the learning center staff work cooperatively toward meeting individual student needs. (See pp. 49-51 for a description of the Writing Resource Center.)

The student population that this institution serves is generally weak in communication skills upon entrance to college. It is typical of most student populations served by historically black institutions today. The communication weaknesses seem to stem from a persistent pattern of neglect; however, upon college entrance, many students will respond rapidly to carefully planned, painstaking instruction geared to their needs. The success of the Kenan Program in teaching communication skills through the disciplines attests to this fact. There is a wealth of evidence on file in support of the effectiveness of this program.

PIAGETIAN-BASED INSTRUCTIONAL TECHNIQUES

The theories of Jean Piaget, the Swiss epistemologist, are gaining considerable attention among American psychologists and educators today after several decades of scant recognition. Piaget's theories of learning were based on his extensive work with children, including his own. Some of the problems that college students have with abstract reasoning have sent professors back to the theories of Piaget for a closer look at his Growth of Logical Thinking from Childhood to Adolescence, as well as his other works. Two areas of particular significance have been identified: the structure and operations of intelligent behavior, and the sequential stages of development.

Briefly stated, Piaget argues that intellectual development is adaptive behavior that results from the need of the organism to achieve dynamic equilibrium between itself and its environment. This is a life-long process known as "self-regulation." Piaget has identified four stages through which an individual passes as he develops from infancy to maturity: (1) sensorimotor; (2) preoperational; (3) concrete operational; and (4) hypothetico-deductive or formal operational. In recent years, some educators have claimed that the last two stages have relevance for college-level instruction. The individual in the third stage (concrete operational) appears to have a coherent and integrated cognitive system by which he or she can structure the past in terms of the present. As development proceeds, individual actions are organized into systems of actions with structural properties. At some point between the ages of 11 and 15, the concrete stage

should give way to the fourth stage (formal operational). However, the performances of a large majority of the freshmen at the historically black colleges and universities indicate that they have not made this transition by the time they arrive on campus. College courses in such areas as the sciences and mathematics require the exercise of problem-solving ability (Piaget's fourth stage--formal operational). The failure of students to develop problem-solving ability increases the attrition rate, especially in the sciences and mathematics, and severely restricts career choices.

Xavier University's Project SOAR in Chemistry. The answer of one of the institutions of this study, Xavier University, to the problem of attrition and career determination in the sciences and mathematics is embodied in a project called SOAR (Stress on Analytical Reasoning) as a component of the Kenan Science Program. The project was initiated at Xavier in the summer of 1976 by the director of the Kenan program (a professor of chemistry) who was aware of the success that a handful of university professors had achieved in their classes with instructional techniques based on Piaget's theories. The Piagetian-based programs that were attracting attention included the development of "learning cycles" at the University of California at Berkeley; ADAPT (Accent on Developing Abstract Processes of Thought) at the University of Nebraska; DOORS (Development of Operational Skills) at Illinois Central College; the Cognitive Skills Program at Essex County College in Newark, New Jersey; and STAR (Steps to Abstract Reasoning) at Metropolitan State College in Denver, Colorado. A detailed description of SOAR is presented in the section of this study titled "Outreach to High School Students and Teachers."

Encouraged by the success of SOAR in 1976, the chemistry department of Xavier began immediately to devise laboratory experiments for science majors similar to those in the SOAR project. A full two-semester sequence of experiments in the learning cycle format was developed. This sequence has been in use since the fall of 1978.

Piaget says of the individual operating in the fourth stage of development:

> (He or she) can now reason on hypotheses, and not only on objects. (He or she) constructs new operations, operations of propositional logic, and not simply the operations of classes, relations, and numbers. He attains new structures which are on the one hand combinatorial, corresponding to what mathematicians call lattices; on the other hand, more complicated group structures. At the level of concrete operations, the operations apply within an immediate neighborhood; for instance, classification by successive inclusions. At the level of the combinatorial, however, the groups are much more mobile.[5]

Frequently, the educationally disadvantaged college freshman has not had enough experience at the formal operational level to enable him or her to engage in the self-regulation required to integrate and internalize the scientific information thrust upon him or her in the entry-level courses. The problem that confronts the professor is often pedagogical rather than a reflection of the student's lack of academic ability. According to Piaget, as the individual progresses through definite stages of development, there is a limit to what he or she is able to comprehend in each stage. Only upon reaching the highest level of development does the individual acquire

---

[5] Richard Ripple and V. N. Rockcastele, eds., Piaget Rediscovered (Ithaca N. Y.: Cornell University Press, 1964), p. 8.

the ability to successfully engage in problem-solving with abstract considerations of possible solutions, according to the relationships between the elements of the problem. This type of problem-solver can use logical analysis and combinatorial experimentation. He sees reality as a subset which paves the way and provides the content.

The contemporary Piagetian programs present students with concrete data but only to help them draw conclusions and test those conclusions by discussion and in the laboratory. For example, the "learning cycle" developed at the University of California at Berkeley has three phases: exploration, which begins with empirical data; invention, which calls for experimentation and analysis; and application, which requires further experimentation, analysis, and refinement, and which allows the student to draw conclusions. The Piagetian-based General Chemistry Laboratory Program for Science Majors at Xavier is predicated upon the three phases of the "learning cycle" which had previously been used successfully at this institution as the format for Project SOAR.

In the first phase, exploration, the student is expected to interact with concrete materials to acquire information about a given chemical or physical system with minimal guidance. He is given no theoretical introduction or information about what relationships to seek. He is allowed to make non-dangerous mistakes without interference from the instructor, who seldom attempts to eliminate extraneous factors (and often purposely introduces them).

In the second phase, invention, the student is asked to analyze the data that he gathered during the first phase. His analysis might include, as appropriate, seeking relationships between variables, making generalizations, constructing graphic presentations, and developing an empirical equation. The instructor asks questions designed to guide the student to a logical analysis of the data. He refrains from telling the student merely to verify a known answer. In so doing, he does not discourage investigation of chemically unimportant relationships, but, instead, encourages further investigation to determine what other relationships might exist. Students are encouraged to work in pairs or groups in the invention phase. At the beginning of this phase, there is usually a short discussion of the data, led by the instructor, which is intended to suggest possible considerations rather than to provide answers.

In the third phase, application, the student is expected to extend the basic concepts from the second phase, invention, in an appropriate manner. This might include making predictions based on the concepts, conducting student-designed experiments which test the prediction, or (occasionally) using self-designed experiments to investigate an area closely related to one perviously studied.

In most general chemistry programs, lecture precedes laboratory. In this Piaget-based program, the laboratory experiments precede the lectures. This technique implements Piaget's theory in that it introduces concepts by way of concrete experience in the laboratory and increases the chances that students, particularly educationally disadvantaged students, will understand

them. Students' understanding of the relationship between concrete experience and the theoretical concepts is further developed at the beginning of the lecture period by a brief group analysis of data similar to that collected previously in the laboratory.

All of the sections of general chemistry laboratory at Xavier have used the "learning cycle" materials since the fall of 1978. The decision to change completely to this program was made after it was noted that all available evidence suggested that both low- and high-ability students would benefit from it.

North Carolina Central University's Physics Project. One of the science departments at North Carolina Central University (NCCU) also subscribes enthusiastically to Piaget's theory of intellectual development as a functional way to teach science. This department (the Department of Physics) offers a Piagetian-type course titled The Language of Science (Physics 121) as a scientific experience for liberal arts, non-science majors.

After observing that most of the liberal arts students at the university are still concrete operational, members of the faculty of the Department of Physics decided that they should develop courses and materials suitable to their students and not simply "water down" existing materials and approaches. Consequently, they developed a special physics course in which the focus is on the intellectual procedure that the students must follow to reach the formal operational thinking that is proper to science. Carefully chosen steps lead the student from a concrete operational mode of thinking to a formal operational mode.

The conrete thinker may be quite capable of understanding the things he or she has experienced in an experiment, but is not able to handle the generalizations derived from that experience. Therefore, in this special course, the discovery approach is used. The students' discoveries become the basis for abstract discussions of important general principles.

In the course, the student is given no outside information which has to be presented formally. Rather, all information and data used in class are based on the student's observations and measurements, and all conclusions are developed by the students with the help of their classmates and suggestions from the instructor. This approach makes it possible for the concrete thinker to relate all of his or her work directly to personal experiences. It also gives the student a much better understanding of the usefulness of the scientific method and the validity of its conclusion than would a neatly packaged formal exposition of the subject.

A course manual has been written and published locally which contains both home assignments and laboratory assignments. Calculators are available for student use. In addition, some computer-assisted learning experiences are provided.

Some of the topics covered in the modified physics courses are: (1) A Case Study of the Interrelationships between Science and Society; (2) The Tools of a Scientist; (3) Functional Relationships; and (4) The Idea of Energy.

NEW COURSES

In addition to the modified offerings, some completely new courses have been generated by the Kenan programs. Two examples of such courses are Literature of Science (Jackson State University) and Scientific Instrumentation in Biology, Chemistry and Physics (North Carolina Central University).

Jackson State's Literature of Science Course. In January 1979, a humanities course entitled Literature of Science was introduced as an interdisciplinary enrichment feature of the Kenan Mathematics Project at Jackson State University. This course, taught by a dynamic professor of English, won immediate popularity with science majors, who appreciated the background it gave them for their scientific studies. By January 1981, enrollment in the one-semester course had grown to such an extent that the course was expanded to a two-semester sequence.

Most of the science departments at Jackson State University require their majors to take one or both segments of the course. The art department now requires art majors to take a segment of the course to broaden their knowledge of science and improve their ability to think analytically. The course focuses strongly upon the development of abstract thinking and the deepening of science vocabulary.

The first half of the course has three objectives: (1) to introduce students to major works in the history of science, (2) to provide models of scientific writing characterized by close logical reasoning and an excellent literary style, and (3) to assist students in developing a

writing style that is both logical and clear, a necessity for scientists and technicians.

The first segment of the course consists of three units: (1) Beginnings of Science in the Ancient World, (2) Origins of Modern Sciences, and (3) Biology Becomes a Science. The required textbooks for this segment are The Origins of Modern Science by Butterfield, Darwin by Appleman, and The Double Helix by Watson.

The students are also expected to read assigned selections from Farrington's Aristotle: Founder of Scientific Philosophy, Bronowski's The Ascent of Man, Kuhn's The Structure of Scientific Revolutions, and Piaget's The Child's Conception of Physical Causality. They are assigned further readings from Great Books of the Western World, which includes selections from the works of Copernicus, Ptolemy, Kepler, Harvey, Gilbert, Galileo, Descartes, Bacon, Newton, Huygens, and Lavoisier.

The second segment of the course consists of five units: (1) Einstein and the Revolution in Physics, (2) Heisenberg and the Uncertainty Principle, (3) Evolution in Earth Science and in Astrophysics, (4) Mathematics in the Arts, and (5) Ecology: Where Science and Aesthetics Meet.

The required textbooks are Writing About Science by Bowen and Mazzeo, This Endangered Planet by Falk, A Canticle for Leibowitz by Miller, The Universe and Dr. Einstein by Barnett, and The Sea Around Us by Carson.

The objectives of this segment are: (1) to provide models of scientific writing characterized by close reasoning and an excellent literary style, (2) to study the relationships between mathematics and sculpture,

painting, music, and other arts, and (3) to assist students to develop a writing style which is both logical and clear.

In addition to the required textbooks, the students are expected to read The Lives of a Cell by Thomas, Experimental Research in Electricity by Faraday, Greek Sculpture by Carpenter, Symmetry in Science and Art, by Shubnikov and Koptsik, and Brains, Machines and Mathematics by Arbib.

In each segment of the sequence, students are given copies of the detailed course outline which contains a selected bibliography.

Upon completion of the two-semester course in Literature of Science, it is expected that the students will be able to: analyze the writings of scientists with increased comprehension of explicit and implicit meaning; understand the application of logic to the development of scientific methods; recognize the importance of mathematics in the development of science and as a prerequisite to a career in science or technology; understand and explain the nature of scientific revolutions; understand the role of the scientist in dealing with ecological problems; enjoy art more as a result of having a better understanding of the structure of aesthetic objectives; and understand the relationship of the humanities to the sciences.

NCCU's Scientific Instrumentation Course. The students' lack of experience with basic scientific instruments posed a problem in advanced science courses at North Carolina Central University(NCCU) since valuable time had to be spent in discussing instrumentation methods before the courses could proceed as planned. Since many important instrumental methods in sciences are in general use, it was decided at this institution that the

best plan of action was to develop an interdisciplinary scientific instrumentation course to be taken by all students majoring in biology, chemistry, and physics. The course was first offered in a limited format in the summer of 1979.

The purpose of the course is to give the upperclassmen majoring in the three sciences--biology, chemistry, and physics--a general knowledge of the theory and application of instrumental methods that are widely used in the sciences, to give practical experience in the operation of instruments and the interpretation of data gathered from the instruments, and to show that these methods can be used to make measurements and solve problems common to all three of the scientific areas.

The experience gleaned from offering the course in the summer of 1979 was helpful in preparation of the faculty involved for teaching the course in its entirety in the spring semester of the 1979-80 academic year. During this semester, the course proceeded as planned, and this first full-scale implementation was very successful. Currently, all of the instrumentation required is in place, and all of the experiments have been developed. The full-scale course is now a regular offering of the three departments involved.

The course in scientific instrumentation in biology, chemistry, and physics offers certain advantages. It is far less expensive than purchasing and maintaining a separate set of instruments for each of the departments. The interdisciplinary aspect of the course promotes interaction among faculty members and students of the three departments. It also broadens

the scientific background of the students and gives them greater appreciation of the various disciplines. The course enhances the science major's value on the job market upon graduation, since most industrial and governmental laboratories seek persons with experience and training in the use of scientific instrumentation.

LEARNING CENTERS

The emergence of learning centers on college campuses has resulted from a wide variety of needs, trends, and developments in higher education. There are many types of learning centers, ranging from those which simply provide tutorial services to those which utilize sophisticated equipment and techniques. These centers did not appear suddenly on the educational scene. They evolved from the painstaking efforts of educators to give individual attention to students with diverse needs, to provide special instructional resources to supplement classroom instruction and textbook materials, and to increase self-confidence of students and augment their motivation to succeed. They reflect acceptance of the view that the individual student is capable of assuming responsibility for much of his or her own learning and that individuals learn in different ways and at various rates.

This document does not attempt to rate learning centers in terms of efficiency or outcomes, but, rather, to provide descriptive summaries of selected ones. Although the learning centers described vary in operational procedures, subject-matter focuses, technological capabilities, modes of delivery, physical designs, and educational resources, their underlying assumption is the premise that students differ and that the college or university must provide for these differences. The learning center enables the institution to achieve the flexibility to manage the teaching-learning

environment to the advantage of the individual student. Usually the learning center becomes the heart of any program designed specifically to improve the student's basic competencies.

The Xavier University Center. From 1976 to 1979, each of the four participating departments (biology, chemistry, mathematics, and physics) in the Kenan Science Project at Xavier University provided extra assistance to the students on an individual basis in separate centers. However, in 1979, a new, combined learning center for the sciences was established in the university library. This facility was named Alternate Pathway Learning Center (APLC). The change to the combined center was most effective. For the first time, an adequate facility was provided in which the four departments could give appropriate support to the underprepared students. In this facility, the four departments share equipment and the responsibility for supervision. Although the APLC is located in the university library, it is considered to be a part of the structure of the departments; and it is managed by a joint committee. Its outstanding success is indicated by the fact that it averages 15,000 entries per month in a total college enrollment of around 1,700 undergraduate students.

Extensive tutorial service, which includes peer-tutoring, is provided in the APLC for students of all departments. Much of this service is interdisciplinary in nature. For example, if a student in chemistry has a mathematics problem, he simply walks across the room to that resource. The individualized instruction offered in the center is supported by a broad collection of educational materials and audio-visual aids. Some of

the instruction is computer-based. Since this center is a library-related activity, the resources are bountiful, and the atmosphere is especially conducive to self-regulation.

The peer-tutors are trained for their role by the faculty members. They are taught how to engage in "cognitive therapy" tutoring. They do not merely give answers or demonstrate the way a problem can be solved. Instead, they lead students toward finding answers for themselves. The students are asked to explain all of the steps in reaching the answers. Throughout a learning session, the tutor constantly watches for instances in which a student arrives at an answer without proper consideration for accuracy or the necessary cognitive steps. The tutor is concerned not only with teaching the subject matter but also with helping the student to develop cognitive skills to the extent that he will no longer need tutoring.

The North Carolina Central University Center. The development of the Mathematics Learning Center (MLC) at North Carolina Central University is currently in progress as a five-year Kenan project which was begun in the summer of 1981. The project addresses several related problems in science education at this institution, such as: (1) the lack of sophisticated mathematics skills found among many science and mathematics students; (2) the preparation of students for science careers requiring knowledge of higher mathematics, fields in which they have been historically underrepresented; and (3) the passive attitude which many students have toward learning and comprehending mathematics.

The project involves five major activities:

1. Providing means of integrating new teaching strategies into the present mathematics and science courses so as to achieve a heuristic approach to the development of formal mathematical concepts through the extensive use of visual conceptualization.

2. Developing and using a comprehensive set of laboratory activities involving computing (and computer-assisted instruction) which will become part of many course requirements. Activities designed to illustrate and reinforce algorithms and techniques and motivate their applications in related areas of science.

3. Developing mathematical modules and their solutions specifically devoted to realistic application problems chosen from the user disciplines.

4. Training faculty members to develop their own software for use in computer-assisted instruction in their own classes.

5. Establishing linkage with selected secondary schools in order to develop a basis for training secondary school teachers in the preceding activities and to provide a pool of better trained students from which to recruit.

Activites 1 and 4 are well underway in the learning center. In addition, some phases of Activity 5 have been completed. Since Activity 5 is an outreach venture, it is explained in this document under the heading "Outreach to High School Students and Teachers."

In regard to Activity 1, 24 mini-modules have already been developed for the materials in the freshman mathematics course, College Algebra and Trigonometry. They cover these topics: exponents, radicals, solutions

of equations, inequalities, relations and functions, and an introduction to graphing. In addition to the modules, one computer-assisted instruction (CAI) unit on the fundamentals of trigonometry has been developed.

The resource materials for the MLC include: the Mathematical Association of America's Calculus film series (nine 16mm films dealing with a variety of topics from the calculus); 16 physical experiments/models, including a harmonic string, a trajectory apparatus, and a transverse wave model channeled to study acceleration, etc.; basic references for the reading area which include the Shaum Outline Series; and a collection of mathematics and science books. The pieces of equipment already in place include an automatic 16mm sound projector, a projection screen, an overhead projector with a two-way writing roll attachment, one Apple II-Plus microcomputer with associated software and printer, and a VCQ-II copier.

The teaching methods include: the use of geometric and physical models to aid the student in perception, to help him understand relationships, and to aid him in comprehension of concepts; the use of mini-modules to provide for self-paced individualized learning experiences with immediate feedback; the use of computer-assisted instructional materials which provide drill and practice, testing tutorials, expository information on new materials, reviews, etc.; and the use of the Sound-Page Playback unit.

As to Activity 4, monthly workshops demonstrating advanced programming techniques and capabilities of the Terak microcomputer are conducted for the

experienced users, and weekly mini-classes are conducted for inexperienced faculty members who wish to learn the Utah Authoring System. The participants in the workshops and mini-classes represent diverse disciplines. This is indicative of the widespread interest in and high degree of enthusiasm and acceptance of computing on this campus. It is also indicative of the interdisciplinary aspect of the Mathematics Learning Center. This center serves all students at the institution of whatever discipline if that discipline involves mathematical skills and the use of CAI techniques.

Although it was too early to obtain empirical data for this study on the effectiveness of the MLC in improving student competencies, there were many indications that the program is on the right track.

The Dillard University Center. In the fall of 1982, a Mathematics Learning Center, similar in purpose and structure to that of North Carolina Central University, will be opened at Dillard University. Detailed preparations are already underway at Dillard to establish a comprehensive learning center to support classroom instruction in mathematics both for majors in the discipline and for non-majors.

The Mathematics Learning Center will play an integral role in the implementation of a revised mathematics program at the university. This program mandates that entering freshmen be divided into three groups, in accordance with their academic preparation and intended subject-matter majors: (1) those who intend to major in the non-scientific fields, excluding business, will follow a two-semester track in Elementary Functions

and Finite/Liberal Arts Mathematics; (2) those who intend to major in the scientific areas or in business will take the Elementary Functions course and calculus I during their freshman year; and (3) those who are prepared to enter the calculus sequence in the first semester of their freshman year will take calculus I and II. The Mathematics Learning Center will provide both peer tutoring and computer-assisted instruction geared to the needs of the students in each group.

The peer tutors will be trained by the director of the Kenan program. Peer tutoring is expected not only to benefit the tutored students, but also to serve as a means of challenging the student tutors.

In an in-service summer workshop, faculty members will be given demonstrations on the uses of computers in the classroom. They will also preview and interact with computer software that can be used to supplement classroom instruction. The staff of the Instructional Media Center at the university will assist in media activities for the Mathematics Learning Center.

The proposed center is expected to serve a vital need in view of the relatively high failure rate experienced by students in the freshman mathematics courses. With the assistance of microcomputers, those students experiencing difficulties in the mathematics courses will be able to reinforce their classroom learning with modular drills. The supervisor of the Mathematics Learning Center will systematically record student use of all packages in the facility, in terms of both content and frequency of use. The Office of Institutional Research will assist the supervisor in developing

and implementing a plan to evaluate the effectiveness of computer-assisted instruction in relation to grades received by students in their mathematics courses.

The Tuskegee Institute Center. To enhance the quality of instruction in the basic services of biology and chemistry at Tuskegee Institute, the Kenan Science Learning Laboratory was developed as an integral facet of the Kenan science project. This unit, located in the biology and chemistry science building, added a new dimension for students seeking review and explanation of basic subject matter. It is attractively furnished, well-equipped, and consists of three adjoining rooms with individual study carrels, a modest departmental library with an increasing inventory of journals, reference books, slide programs, films, tapes, and other learning resources. The center is staffed with a full-time director and two student assistants. It is used extensively and actually serves as the center for intellectual activities in the science building.

The Jackson State University Center. A tutorial laboratory called the Kenan Math Center was developed as a phase of the Kenan mathematics program at Jackson State University upon the program's inception during the 1978-79 academic year. However, in August 1980, the Kenan Math Center was moved from the Department of Mathematics and made part of an institution-wide Academic Skills Center. The housing of all tutorial services in the same campus area as a facet of the Academic Skills Center served to increase cooperation among the various disciplines. The mathematics phase of the Academic Skills Center has a full-time

coordinator and about 20 student tutors. The new facilities are attractive, spacious, and comfortable.

A signing-in procedure is used in the center:

1. Students sign in on a general skills sign-in sheet.
2. Activities are recorded in individual files.
3. Tutors sign and document the activities related to tutoring.

The mathematics resources in the Center include a large number of films and slides with sound tapes on the fundamental mathematical operations, study carrels, a complete set of videotapes based on the textbook Elementary Algebra by Charles McKeague, video monitors, and a large collection of reference books and materials.

The mathematics tutors are trained for their work by faculty members. They participate in various learning activities and workshops designed to sharpen their tutoring skills. Although many resources are available to the students, they prefer tutors, according to the coordinator of the mathematics area.

Since records are kept only on use of the Academic Skills Center as a whole, figures are not available on student use in mathematics. From 600 to 900 visits per month are made to the Center by students. The dominant tutoring appears to be done by mathematics and computer science majors. The students seeking help in mathematics come from a wide range of courses. The Center not only serves the students with weak backgrounds in mathematics but also serves the mathematically gifted students who need extra challenge.

Computer-assisted instruction in the Kenan mathematics project at this university will be offered in the Computer Laboratory. Twelve Commodore PET microcomputers have been purchased for this purpose. An instructional software package has been obtained from Sheridan College of Ottowa, Canada. In this connection, a workshop was conducted at the institution by personnel from Sheridan College to familiarize faculty members with materials and the machines. There is a positive attitude toward CAI at Jackson State University, but, presently, the CAI phase of the Kenan mathematics project is in the developmental stage.

The Virginia Union University Center. The Writing Resource Center at Virginia Union University is an interdisciplinary learning laboratory designed not only to serve the students at the university who need individualized instruction in order to improve their basic writing skills but also to serve persons in the community who desire to improve their communication skills or to increase their knowledge of the English language. The center began as a Writing Skills Laboratory during the 1976-77 academic year to serve the participants in the Kenan program, "Teaching Communication Skills Through the Disciplines." During the first four years of its existence, it developed rapidly into a broad-based facility; and in the fifth year, the last year of the Kenan grant period, it was formally designated as a Writing Resource Center to serve persons from the community as well as the students of the university.

The Writing Resource Center is a spacious, well-equipped, and well-appointed facility. It is staffed with a full-time writing laboratory

supervisor/tutor and several peer tutors. The supervisor/tutor assists instructors by locating for them instructional materials, such as filmstrips and modular units, which they wish their students to use in the classroom or in the learning center; keeps the audio-visual equipment in readiness for use; tutors students in the center; maintains records of attendance and the nature of assistance to users of the Center; maintains records of referrals to the Center; trains the peer tutors; and supervises the operation of the facility.

The Writing Resource Center is usually a very busy place. Besides the regular attendance of students on an individual basis, instructors sometimes take whole classes to the facility for orientation. The records attest to the impact that the Center is making upon the instructional program. As an illustration, in the month of September 1981, 402 students (out of a total population of around 1,100) were served in the Writing Resource Center. Instructors in all of the disciplines at the institution constantly refer students who exhibit serious writing problems in their classes to the center for special help.

The principal feature of the expansion of the writing laboratory into a Writing Resource Center included the addition of scholarly materials concerned with the following: language used by blacks; research on the English language; the importance of good writing to career advancement; how to write; scientific and technical writing; and writing as a career. Personnel from the university library catalogued the new acquisitions. However, to insure easy access to requested information, additional details on some of the listings were written by faculty members.

The main function of the Writing Resource Center at Virginia Union is to provide support for the program in communication arts by facilitating individualization of instruction. It enables the program to accommodate a great diversity of learning styles and needs because it provides one-to-one teaching-learning options not normally possible in the classroom. Success in the learning centers, however, depends to a great extent on the coordination of classroom instruction and tutorial instruction. Thus, there is very close cooperation between the supervisor/tutor and peer tutors of the Writing Resource Center and the classroom teachers. Regular team meetings are held in which policies and procedures are discussed and student needs are translated into prescriptive strategies.

Although the results attained in the Writing Resource Center toward improving the students' writing skills have not been isolated and quantified, the attitudinal assessments by both the classroom teachers and the students themselves indicate that the tutorial services and the resources provided by the center are definately meeting the students' needs. The focus upon the uniqueness of each individual student with respect to his or her deficiencies, needs, and rate and patterns of learning is an invaluable technique in the education process.

The Benedict College Center. An eminent educator, E. L. Thorndike, postulated as early as 1912 that human beings should be saved for the tasks in education that inanimate objects cannot do. He wrote, "Just because personal teaching is precious and can do what books and apparatus cannot, it should be saved for its peculiar work." His thesis that a

teacher's time and energy should not be wasted in doing what a ream of paper (or a computer) can do might be an appropriate summary of the reasons for the creation and widespread use of computer-assisted instruction (CAI) in the schools and colleges today.

The Kenan program at Benedict College is an example of the use of CAI as a viable means of augmenting instruction in science and mathematics. The overall objective of this Kenan project is to increase the number of science and mathematics majors. The long-range goal is to increase significantly the number of graduates in scientific and mathematical fields who will be able to compete successfully on the job market in scientific and mathematical fields in which blacks are vastly underrepresented.

The Computer-Assisted Learning Laboratory in Mathematics and Sciences at Benedict is designed to help students overcome their fear of mathematics and science through individualized instruction. The computer packages are constructed by the teachers, who can monitor the activities and the levels of performance of the students as they use the terminals in the laboratory. In addition to the director of the program, the staff of the laboratory consists of a full-time supervisor and nine student assistants.

Many of the entering students at this institution tend to choose fields other than mathematics and science as majors. Because of their minimal preparation in such fields, they doubt their ability to succeed. In recognition of these difficulties, the program intends to strengthen the mathematical skills and backgrounds of the entry-level students and thus alleviate the problems of minimal preparation. Effort is also made to

increase the visibility of the mathematics and sciences areas on the campus. In the meantime, the students are given extensive career information. They are apprised of the opportunities available in the science and mathematics fields and the qualifications they must have to compete successfully in the job market in these highly lucrative areas.

The main thrust is to improve student preparation in mathematics and sciences through computer-assisted instruction. For the most part, the CAI materials are integrated with the units of the corresponding courses. In this connection, modules have been developed by the instructors of Earth Science, Principles of Biology, Physical Science, and College Algebra. The first three courses include modules for each unit, organized according to one of the following formats: (1) glossary, (2) multiple-choice practice questions, and (3) problem sets. Because of notational problems, modules were not developed for each of the College Algebra units. In addition, some pertinent CAI materials have been purchased for use by the students in the laboratory.

The students are using the laboratory regularly and effectively. Their response on a questionnaire administered by the director of the Kenan program indicated that they are favorably impressed with computer-assisted instruction and that their grades have improved as a result of what they have learned by using the CAI materials. A study of the grades of a random sampling of students who used the CAI laboratory versus those who did not showed that a higher percentage of the students who used the laboratory made grades of "C" or better.

The Division of Health and Science at the college is now getting a higher percentage of students as majors than it did before the CAI laboratory was established. Ten percent of the senior class of 1980-81 majored in mathematics and sciences.

Another impact of the project is that students are benefiting significantly from the exposure to advanced technology. To become well-educated in today's world, one should have some exposure to computer systems. The CAI laboratory enhances the academic backgrounds of the students in very meaningful ways through the experiences it provides relative to computers and computer operations. One very important spinoff of the CAI laboratory has been the increased interest of the students in computer sciences. This interest has resulted in expanded offerings in computer science and increased enrollment in related science and mathematics courses. It should be noted that approximately 30 percent of the students enrolled at the college use the Computer-Assisted Learning Laboratory in Mathematics and Sciences each semester.

OUTREACH TO HIGH SCHOOL STUDENTS AND TEACHERS

To attract more of the better high school graduates, the historically black institutions are reaching out to the secondary schools in the geographic areas which they serve with more than rhetoric and recruitment folders. They are devising innovative and ingenious projects which bring the high school students to the campuses to experience for themselves some of the opportunities which the institutions afford. They are helping minority students plan for the kinds of postsecondary educational experiences that are not only commensurate with their needs but also with their potentialities for success.

Because minorities continue to be heavily underrepresented in employment in such areas as mathematics and the sciences where remuneration is high, some of the historically black institutions now have outreach programs which enable them to identify, at the pre-college level, potential students in these areas. They also have developed in-service programs for high school teachers to augment their knowledge and upgrade their instructional techniques in such targeted areas as mathematics, sciences, and communication skills.

In the wake of desegregation, many of the academically gifted black high school graduates have been attracted to historically white institutions through massive recruitment efforts and lucrative scholarship offers. This

has resulted in an erosion of the academic talent formerly found in the freshman classes of the historically black institutions. Equality of access does not result automatically in equality of opportunity; therefore, the drift of talented black students back to historically black institutions is becoming noticeable. By upgrading their recruitment activities and refining their outreach programs, the historically black institutions can attract larger numbers of well-prepared, academically capable, black high school graduates who can achieve baccalaureate degrees in such highly demanding areas as mathematics and the sciences.

Brief descriptions of viable outreach projects devised and implemented by the institutions of this study follow.

CAMPUS TOURS

Periodically, the director of the Kenan project at Benedict College extends invitations to high schools in the geographic area to send students and teachers to visit the computer facility to observe computer-assisted instruction and also to tour the campus. Activities for the visitations are well-planned with a view toward increasing the visibility of the Health and Science Division and attracting more students as majors in the sciences and mathematics.

Although the emphasis is on targeted areas of the Health and Science Division, the students are given extensive information about the college as a whole. The demonstration in the Computer-Assisted Learning Laboratory in Mathematics and Sciences include computer games and learning experiences with computer-assisted packages. The students are also shown various

features of the computer and its operation. Efforts are made to put the students at ease and to make the visits enjoyable as well as informative.

A component of the Kenan project at North Carolina Central University includes a provision which brings students from the eleventh and twelfth grades of selected high schools to the campus for a one-day visit. Students not only tour the campus but they also attend mini-lectures in one or more areas of science (including computing) accompanied by a laboratory demonstration and experiments. The specific focus is on the use of sophisticated instrumentation to learn basic scientific principles.

The ultimate aim of this outreach project is to provide a pool of better-trained students from which to recruit majors in mathematics and science.

MATHEMATICS/SCIENCE OLYMPIAD

The Mathematics/Science Olympiad at Xavier University is an annual event. It is designed to give high school students who have outstanding academic ability in mathematics and/or science an opportunity to demonstrate that ability and gain recognition. The Olympiad consists of individual competitions (via short examinations) in biology, chemistry, mathematics, and physics; a competition for the highest individual overall who enters three or more individual competitions; and a team competition in which groups of four students compete representing their high school.

The event was labeled the Mathematics/Science Olympiad to emphasize its similarity to the Olympics in terms of (1) competition and (2) its

intent to provide recognition for performance. Invitations to participate in the event are extended to all high schools in New Orleans, to many throughout Louisiana, and to some in surrounding states.

The Mathematics/Science Olympiad has been a success from its inception. For example, in its second year (1977-78), 133 students from 28 high schools participated; in the 1980-81 academic year, 300 students from 42 high schools in Louisiana, Mississippi, and Alabama competed in the day-long program of academic testing. The examinations were based on college instruction. The event is designed to encourage high school students to pursue careers in mathematics and sciences.

PROGRAMS FOR HIGH SCHOOL TEACHERS

As a facet of its Kenan project, Virginia Union University offered four mini-course/seminars "designed to serve public school teachers needing to brush up teaching techniques and knowledge of language use and style." Discussions in the mini-course/seminars tackled the meaning of "minimum competency" and its implications for the students as well as its impact upon the evaluation of the teacher. Teachers of various disciplines who were concerned about the communication skills of their students, as well as teachers of English composition, were invited to participate.

Another facet of this outreach project involved the expansion of the Writing Skills Laboratory at the institution into a Writing Resource Center to be utilized by the high school teachers and other persons from the community along with the college students. The expansion included the acquisition of a large stock of materials for the center such as scholarly

works concerned with language usage of black people and research in the teaching of English. It also included the acquisition of additional films and filmstrips on English and descriptive materials relating to career advancement and writing.

At Jackson State University, a new course, Literature of Science, (see pp. 35-37) has been so well received as an undergraduate course that Jackson State plans to offer it in the near future as a graduate course. Offering this course to in-service teachers at the graduate level would add a new dimension to instruction in science and literature in the high schools in the geographic area served by the university.

A vital aspect of the new Kenan program at Dillard University is an outreach program involving both promising high school mathematics students and designated high school teachers of mathematics. One of the chief responsibilities of the director of the program is to establish rapport with selected high school teachers. Through an annual one-day seminar, the high school teachers are provided in-service training experiences. With the assistance of nationally known consultants, members of the faculty focus on the development of motivational and teaching methods which will assist the gifted student in advancing more rapidly.

The cooperating high school mathematics teachers are requested each year to identify approximately 10 promising students for participation in an intensive six-week summer program at the university. The purpose is to increase the number of students at the university who choose mathematics or mathematics-related career options by (1) identifying promising mathematics students

and (2) sustaining their interest prior to their graduation from high school. A description of the intensive six-week project for high school students is presented under the heading of "Summer Programs for High School Students."

A number of high school mathematics and science teachers have been employed each summer in the SOAR program at Xavier University for high school students. (See "Summer Programs for High School Students" for a description of SOAR.) Through this practice, the high school teachers gain experience which might be useful in their own classrooms and the university gains contact needed to identify and successfully recruit students who are interested in mathematics and sciences.

In an effort to provide in-depth experience for high school teachers seeking information about the various teaching strategies in use in the sciences at the university, the Departments of Chemistry and Physics each employ a high school teacher to offer instruction in entry-level courses in chemistry and physics for a year. These teachers are on leave of absence from their high schools during the time.

SUMMER PROGRAMS FOR HIGH SCHOOL STUDENTS

Project SOAR at Xavier University. Project SOAR (Stress on Analytical Reasoning), a pre-college, six-week summer program at Xavier University, was initiated in 1976 as a cooperative effort by the science departments. Of particular interest to these departments was the possibility that Jean Piaget's theory of intellectual development could provide a basis for formulating instructional strategies to help educationally disadvantaged students to develop problem-solving ability, and, thus, make the sciences

more accessible to them. The interest of the science departments in Piaget's theory was predicated upon the recent revival of interest in this country in this theory and its implications for science teaching.

The primary objective of Project SOAR is to increase the performance in and reduce the attrition from science and mathematics courses so as to increase the number of qualified graduates in the sciences. Each summer since 1976, more than 100 pre-college students have been enrolled in Project SOAR. This outreach project has been exceedingly successful. Most SOAR participants subsequently enroll in the university as freshmen and become natural science majors. In 1976, the institution had a full-time enrollment of 1,612, with only 26 percent of the students majoring in the natural sciences. In the fall of 1980, the enrollment was 2,003, with 40 percent of the students majoring in the natural sciences. By 1981, the percentage of students majoring in the natural sciences had risen to 42 percent. The growth of student enrollment in the natural sciences has been accompanied by dramatic increases in the placement of graduates in science-related fields. From 1978 to 1980, approximately 140 of the science graduates were accepted in health professional schools or science graduate programs. In 1981, 17 of the science graduates were accepted in health professional schools, at a time when the number of blacks accepted in medical schools was declining nationally by 3.2 percent.

The program consists of three major components: Piagetian-based laboratory experiments to improve general problem-solving skills, analytical reasoning/reading comprehension using a "cognitive therapy" approach, and

vocabulary building. The instructional staff is composed of regular science and mathematics faculty members from the university, high school teachers, and pre-medical and pre-dental students who have just graduated from Xavier.

To provide individual instruction, the participants are divided into groups of approximately 25 students, and a pre-medical or pre-dental student is assigned to each group as a group leader/mentor/role model/parent image, etc. This group leader not only guides the students through the various components of the program but also organizes social activity and works to motivate each student toward maximal achievement.

Each of the 20 Piagetian-based laboratory exercises used in SOAR is organized as a "learning cycle" and contains exploration, invention, and application phases to promote development of the abstract thinking which is necessary for success in mathematics and science courses. There are five "learning cycles" from each of the disciplines of biology, chemistry, mathematics, and physics. All of them have been developed by members of the science faculty as units which emphasize major components of problem solving, such as the abilities to: (1) identify and control variables, (2) use proportional reasoning, (3) consider exhaustively all combinations of factors, (4) use probabilistic relationships, and (5) recognize correlations between variables.

The laboratories are conducted by a combination of science and mathematics faculty members and high school teachers. The "standards with sympathy" philosophy of the university is pervasive. Solving a problem is a cooperative group effort, with the teacher circulating through the

room asking questions which require the students to verify answers, further test, devise additional experiments, or extend their knowledge. In the problem-solving process, the teacher refrains from lecturing. Questions are answered in a manner that requires additional thought on the part of the student.

The second component of SOAR attempts to teach the students the type of step-by-step logical reasoning needed for successful performance on standardized tests. The "cognitive-skills approach" espoused by Arthur Whimbey, a former faculty member of the university, is employed as the teaching method. Whimbey is the author of the book Intelligence Can Be Taught.[6] He is also the author of a Phi Delta Kappan article entitled "Teaching Sequential Thought: The Cognitive-Skills Approach" in which he states:

> The ability to proceed through a sequence of analytical steps is the foundation of all higher order reasoning and comprehension.
>
> It is what psychometrists call "academic aptitude" or "intelligence." All complex abstractions, classifications, transformations, problem solutions, and applications of generalizations are products of accurate, sequential thought. But many of today's high school and college students have not sharpened this ability sufficiently for even moderate success in academic work.
>
> Weaknesses surface in all areas, ranging from mathematical problem solving to the comprehension of history.[7]

---

[6]Arthur Whimbey, Intelligence Can Be Taught (New York: Dutton, 1975).

[7]Arthur Whimbey, "Teaching Sequential Thought: The Cognitive-Skills Approach," Phi Delta Kappan (December 1977), p. 255.

To familiarize the students with the general aspects of cognitive therapy the component is initiated through the use of Problem-Solving and Comprehension: A Short Course in Analytic Reasoning by Whimbey and Lochhead[8] as a text for the first third of the program. A workbook in algebra is used in the quantitative portion, and selections from the ETS Graduate Record Examination Information Bulletin, the American Dental Association's Dental Admissions Test Preparation materials, etc. are used in the verbal section. The cognitive-skills instruction is conducted by the medical-dental student group leaders after training by, and with supervision from, members of the faculty who are skilled in the approach.

The third component of Project SOAR consists of a concentrated, systematic focus upon vocabulary-building, since vocabulary is a prerequisite to good reading comprehension. Vocabulary-building drills are conducted for 30 minutes per day from Monday through Thursday using Vocabulary for the College-Bound Student by Levine as a text.

Carefully controlled competition between the groups is used as motivation, since students are seldom enthusiastic about building vocabulary skills, improving reading comprehension, or cognitive therapy. The competition consists of a required hour-long written test covering the previous week's work in both analytical reasoning (cognitive therapy) and vocabulary building, and a short quiz bowl. Four students represent each group in the quick-answer quiz bowl. At the conclusion of the quiz bowl,

---

[8]Arthur Whimbey and Jack Lochhead, Problem-Solving and Comprehension: A Short Course in Analytic Reasoning (Philadelphia: Franklin Institute Press, 1980).

scores from the written tests and quick-answers of the quiz bowl are added. Then, with great fanfare, the group with the highest score is awarded the special SOAR trophy for the week.

In the competition, points are purposely scaled so that the performance of the group as a whole on the written test is a major factor in determining the winning group. The quiz bowl serves primarily to stimulate interest and generate spirit among the remaining members of the group, who act as a cheering section for their representatives. There are restrictions concerning repeat appearances designed to insure that most students will have the opportunity to represent their group in the quiz-bowl competition. Deliberate efforts are made to use the group spirit to facilitate the paired problem-solver/listener approach used in the cognitive therapy method so that the students who have scored well will work willingly with those who have not scored well, "for the good of the group."

More than 90 percent of the students completing the SOAR program each year enroll as full-time students at Xavier University and choose majors in mathematics and the sciences. Further illustrations of the tremendous success of the project are the following measures indicated in the director's report to the Southern Regional Education Board (1980): (1) Students completing SOAR made statistically significant gains on Lawson's test of intellectual development. The assumption is that increased intellectual development translates into better grades in mathematics and sciences. (2) Students who had lower than a twelfth-grade reading comprehension at the beginning of their SOAR experience showed an increase of 1.4 in grade

level at the end of the summer program. (3) Students who had lower than a twelfth-grade vocabulary at the beginning of their SOAR experience showed an increase of 1.8 in grade level of vocabulary at the end of the summer program. (4) SOAR participants showed an average increase on the PSAT equivalent to 73 points on the SAT on pre-tests and post-tests administered during the program. If, as commonly thought, these tests are related to performance in college, it is obvious that SOAR is rendering gargantuan services.

The SOAR project received national attention among educators as a result of (1) being featured, among a select number of interdisciplinary programs, in a series of reports on teaching in Change magazine in 1978, and (2) being included in an article on Piaget's legacy in American education in The Chronicle of Higher Education, September 1980. Other published articles pertinent to this program include "Project SOAR (Stress on Analytical Reasoning): A Multidisciplinary Summer Program for Minority Science Students," The American Biology Teacher, March 1980; "Teaching Critical Reading and Analytical Reasoning in Project SOAR," Journal of Reading, October 1980; "Special Report: Project SOAR," This Week at Xavier, Volume 9, Number 46, December 9, 1980; and "Xavier Pre-Med Students Thrive Despite National Trend," reprinted from Philadelphia Tribune, May 5, 1981.

The Future Scientist Enrichment Program at Jackson State University. Since 1979, an outreach project for high school students modeled after SOAR, and known as the Future Scientist Enrichment Program, has been an outstanding success at Jackson State University. The Future Scientist Enrichment

Program consists of four components: Mathematics, Analytical Skills Development, Literature and Readings for the Future Scientist, and Computer Programming. The staff for the program is composed of university faculty members and student assistants.

Students in the high schools in the Jackson, Mississippi area are invited to participate in this eight-week summer program. The program has reached a considerable number of talented secondary school students. It has enabled the instructors to find and direct some very capable students into scientific and technological fields.

A placement test in mathematics is given at the beginning of the program, and each student is placed in one of the following four courses in accordance with his scores: Calculus, Algebra and Trigonometry, Intermediate Algebra, or Elementary Algebra. Each phase is equivalent to a course offered to the regular students at the university.

A self-paced approach to learning is employed as a technique in Elementary Algebra and Intermediate Algebra. Each class period is two hours in length. The materials used in the two courses are from McKeague's Elementary Algebra and Intermediate Algebra.

For the Algebra and Trigonometry course, Swokowski's Fundamentals of Algebra and Trigonometry is used as a textbook; and for the Calculus component, the textbook is The Calculus with Analytical Geometry by Leithold. The class period for each of these courses is two hours in length, but it is divided into two sessions--one hour for instruction and one hour devoted to problem solving.

At the beginning of the program, Whimbey's Analytical Skills Inventory is administered to all the students to determine their placement in the Analytical Skills Development component. The students are divided into three homogeneous groups in accordance with the results of the inventory. The groups meet one hour per day, for four days each week, with a faculty member assigned to each group, for problem analysis and the development of skills needed to solve problems systematically. For this component, Problem-Solving and Comprehension: A Short Course in Analytic Reasoning, by Whimbey and Lochhead[9] is used as a textbook.

The English component has varied each summer since the inception of the program to accommodate the needs and interests of the students. During the first summer, students read a collection of short stories entitled Science Fiction/Fact, edited by Edmund J. Farrell.[10] The stories were excellent springboards for the introduction of related non-fiction science writing and were helpful as tools in scientific vocabulary-building exercises. Films were used to supplement the readings.

In the second summer, the focus was on the planet Earth and its people. After a study of plate tectonics, the students were expected to name and locate the continents as they are today and to know the names of the countries within each continent. A survey of the culture of each continent followed, illustrated by films, lectures, and readings. Europe was studied

[9] Ibid.

[10] Edmund J. Farrell, Science Fact/Fiction (Glenview, IL: Scott, Foresman & Company, 1974).

last, and the second half of the course dealt with the scientific discoveries characteristic of Western culture. Films from Bronowski's Ascent of Man series were used, as well as slide shows on plate tectonics, and the "Big Bang" theory of cosmology.

In the following summer, the English component focused on technical writing. The students were given extensive practice in expanding and combining sentences and developing paragraphs. Special attention was given to vocabulary development, particularly in the early weeks of the session. In the second half of the course, the students read widely and viewed films and slides to gather information of a scientific nature in preparation for writing essays. By the final week, a large percentage of the students were writing essays which compared favorably with the work of college freshmen and sophomores at the "A" and "B" levels.

The newest component of the Future Scientist Enrichment Program is Computer Programming. The textbook for this component is Hands-On Basics with the PET. The topics covered in the class include: (1) Systems Commands: LIST, RUN, STOP, NEW; (2) Variable Names in BASIC; (3) Arithmetic on the Computer; (4) Use of Parentheses in Computing; (5) "E" Notation Numbers; (6) Storing and Retrieving Programs; (7) Printing out Variables and Strings; (8) Spacing the Printout; (9) The REMARK Statement; (10) Built-In Looping; (11) Built-In Functions; (12) Finding Errors in Programs; (13) Editing; (14) Solving Mathematical Problems; and (15) Animating your PET.

The ACT test is administered twice to the students in the program--at the beginning and at the end. The scores that the students make on the pre-test and the post-test are compared to determine the extent to which

the program is succeeding. A summary of the ACT test results for the summer of 1981 follows.

Subject	Initial	Final	Percent of Increase
English	14.648	17.261	17.838
Mathematics	14.370	19.326	34.488
Social Studies	12.13	15.348	26.530
Natural Science	16.037	19.370	20.783
Composite	14.352	17.739	23.599

It should be noted that the percentage of improvement in each area covered by the test is commendable, with the greatest improvement being made in mathematics. This program is making a significant contribution to the efforts of historically black institutions to increase the number of graduates in mathematics and sciences. Many of the participants of the program enter college upon graduating from high school and elect mathematics, science, or science-related programs as majors.

The Dillard University Summer Mathematics Program. At Dillard University, the outreach project for secondary school students is designed to bring 10 promising, rising high school seniors to the campus for an intensive six-week summer program in mathematics each year. These students will return to the campus for a successive, intensive, six-week summer program upon graduating from high school, thereby increasing the chances of their continued growth as students of mathematics, as well as increasing the probability of their ultimate enrollment at the university. Prospective students for the program will be identified each year by cooperating high school mathematics teachers who will participate in an annual in-service seminar in mathematics at the university.

In the first six-week summer program, the students will be involved in an intensive algebra review and an introductory course in logic. In their second summer program, they will be engaged in an intensive study of trigonometry and pre-calculus with a view toward preparation for the study of calculus in the first year of college. An integral part of their classroom experience will be required laboratory work, wherein they will be assisted by tutors and microcomputer units. Along with the trigonometry and pre-calculus, the recently graduated high school seniors, or "bridge" students, will study analytical reasoning and participate in weekly seminars. At these seminars, persons employed in mathematics or mathematics-related areas will discuss their work and entertain questions from the students.

The summer program will afford the promising mathematicians opportunities to interact with teachers in a setting that challenges them to go beyond standard mathematics. Besides serving as role models, the teachers will direct the students to supplementary texts and resources.

This outreach project, supported by a Kenan grant, is just getting underway. Therefore, no report of its progress can be made at this time. The project intends, however, to include some unique activities beyond traditional classroom instruction. To broaden their perspectives and to make them aware of the importance of mathematics in contemporary occupations, the students will make site visits to industrial corporations, law firms, engineering plants, and other businesses in the local community. Allowing students to observe black role models in their actual occupational settings should enhance the students' motivations to achieve the status

of professionals in mathematics and mathematics-related fields. In addition, the parents of the participating students will be invited to participate in an orientation conference, and it is hoped that this phase of the outreach program will foster a common bond of support in working toward achievement of the students' career goals.

INSTITUTION-WIDE SUPPORT SERVICES

Specific programs for the improvement of student competencies and for increasing student retention to graduation will not be effective without strong, categorical support services which reflect institution-wide cooperation. Full commitment to the objectives of such programs and to the special techniques involved must be provided by the central administration and the respective deans of the college or university at which implementation is attempted. In addition, faculty, by and large, must understand and support the program.

There are some faculty members who tend to think of programs designed to help students overcome their deficiencies as lowering standards. They prefer "weeding out" the underprepared students. This kind of attitude is counterproductive and self-defeating since recent studies indicate that as many as 50 percent of the students who enter the colleges and universities today cannot reason abstractly in the manner needed for college courses. The obvious solution to the problem is to start with the student where he is by modifying curricula and instructional techniques in such a way that the educationally disadvantaged students will be assisted to achieve success, and, at the same time, high academic standards will be maintained. Programs designed to accomplish this phenomenal task will succeed only in institutions that give full support to such programs.

Fortunately, there are special programs, such as those cited in this document, to which remarkable institution-wide support has been given. To solicit the kind of support needed, the persons in charge of the program have held conferences not only with the presidents, vice presidents, deans, and other administrators, but also with the various academic divisions and departments to explain the programs, engage in discussions relative to the programs, and seek advice. In most instances, this interaction had laid the foundation for success in the implementation of the programs.

Faculty development dimensions should involve activities not only for the faculty members engaged in the program activities, but also for any faculty members whose departments may be affected by the program's results. Faculty workshops, summer activities, and site visits are valuable both for those involved in the special programs and for those whose students employ the skills and knowledge developed in the special programs. Therefore, interdisciplinary cooperation is of the utmost importance in the thrust to improve student competencies. For example, mathematical performance depends heavily upon verbal skills; mathematical skill is the root of competence in the sciences; analytical reasoning is the key to abstract knowledge; and communicative arts are pivotal in all learning experiences.

The institution's counseling services carry a major responsibility for supplementing the counseling services built into the special programs. This responsibility is assumed more readily on campuses where all counseling resources have been coordinated. The importance of coordinated counseling services in higher education is ably set forth by Anne S. Pruitt in her

publication titled New Students and Coordinated Counseling. Pruitt offers an impressive list of recommendations to improve the capability of colleges to serve the needs of all their students. Those cited below have specific implications for the programs described in this study. Pruitt recommends that:

> Each institution examine its commitment to students, especially the "new students" now entering America's colleges, and determine how the program of education, with the assistance of counseling activities, can best respond to that commitment.
>
> Responsibility for directing the coordinated counseling program be assigned to an individual who is specifically educated in the field of counseling and who has the potential for successfully administering the program.
>
> Emphasis be placed upon the services "new students" seem to need, such as academic support, financial aid counseling, career counseling, counseling on matters involving self-esteem and identity, admission to graduate and professional schools, and counseling for veterans and older students.
>
> Lines of communication be opened so that the program can reach out to any segment of the institution where growth and development of students can be enhanced, using new settings and new techniques for the delivery of services.
>
> Where there are institutional programs with counseling components that cannot be brought into the centralized program, an interface be created with them.
>
> A testing program be conducted that is pertinent to the student and instititutional needs and sensitive to the biases against non-traditional students.[11]

---

[11] Anne S. Pruitt, New Students and Coordinated Counseling (Atlanta: Southern Regional Education Board, 1973), p. 1.

Pruitt postulates that the historically black institutions are among that group of colleges and universities that seem to be especially well-suited to the development of coordinated programs of counseling. She alludes to the concern of the historically black institutions for the individual welfare of the students. In this connection, she states:

> Faculty and staff are known to work with students intensely to help them succeed. Students are friendly and interested in helping each other. After they graduate, their attachment to the institution is often unusually strong. Many have been made to feel that they matter as individuals. Moreover, it is well known that these institutions have succeeded in teaching not only the promising students, but also the so-called high-risk students. Many of these institutions have reduced the odds and have produced the vast majority of black leaders in America.[12]

Coordinated counseling plays an important role in meeting the exigencies of educating the whole student. It enhances the student's chances for success in college because it maximizes the efforts of the institution to respond to his or her total educational needs.

Because recruitment procedures and admissions policies vary from institution to institution, it is essential that the planner of a special program be thoroughly familiar with the rules and regulations at his particular institution so that the provisions of his proposal will be consonant with them. It is also essential that the institution's recruitment and admissions officers give their full support. The coordination of recruitment and admissions activities will provide maximum opportunity for the institution to serve a projected number of students with special needs and

---

[12] Ibid., p. 3.

also to increase the number of majors on the campus in such fields as mathematics and the sciences, in which minorities are greatly under-represented.

It is essential that the special programs receive fiscal support on a continuing basis. Even though many of the special programs are started with outside funding, they should be structured so that when the funds are no longer available, the essential components of the special activities may be built into budgetary support.

Evaluations of the special programs to improve student competencies are highly necessary. These evaluations should include appraisals of the worth of the programs, both to the goals of the institution as a whole and to the commitments which are implicit in the programs themselves.

CONCLUSION

A repertoire of basic knowledge and skills is required for successful performance in college-level courses. However, many of the minority students in America who now are enrolling in institutions of higher education do not have the requisite basic competencies for success in courses at that level of instruction. Consequently, there is an imperative need at the colleges and universities to provide programs to maximize the chances that these underprepared students will be able to overcome their deficiencies and achieve success in their academic endeavors.

Cognitive skills and awareness, including abstract thinking, are essential to give meaning to the mechanical processes included in the basic competencies. A clear understanding of the nature of numbers must undergird the process of manipulating numbers, and an awareness of language structure is basic to the development of communication skills. While these concepts should have emerged during the student's elementary and secondary school experiences, they may still be developed at the college level. The growth of abstract thinking skills is a key factor for success in postsecondary education, and the evidence from such techniques as those suggested by Piaget have produced dramatic results, particularly in the sciences.

Remediation programs are substantially more successful when offered in a positive rather than a negative setting. There need not be a stigma attached to a program which is designed to provide an opportunity for students to advance toward their educational and career goals. The learning centers which have been described are, for the most part, used voluntarily by students, and the benefits derived may be clearly perceived. As evidenced by the special programs described in this study, through well-planned modifications, standard college curricula can be developed into intellectually rigorous "bridge" courses that not only improve the students' basic competencies, but also will, concomitantly, maintain integrity as college-level courses.

The various competencies which the students need are interrelated. Teachers of mathematics are particularly aware that students often have difficulty because they cannot read and understand a problem nor grasp a verbal definition of a mathematical relationship. A common denominator to the varied programs described has been their interdisciplinary character. This posture does not emerge unless faculty from differing disciplines work together in identifying the causes of academic difficulties encountered by students.

A highly significant characteristic of successful projects to improve basic competencies is that they have been generated and implemented by faculty. Most of the programs described in this study were initiated by faculty groups who were given released time for that purpose or who were given financial support for summer workshops during which the project was planned.

The involvement of high school teachers and counselors in the design and execution of special programs in the development of competencies is often highly productive. Their inclusion has two benefits. The high school faculty contribute to an understanding of weaknesses which high school graduates often exhibit, and are able to transfer some of the techniques designed at the college level to their own high school activities. The outreach by the college to high schools also motivates students to give serious consideration to attending college, and participation in campus visits and activities provides for quicker adjustment when they arrive on campus as students.

Finally, the motivation of students may be the most important factor in the success or failure of special programs in compensatory instruction. It is difficult, perhaps impossible, to isolate the particular effects that each special technique has had upon college success, since students in these projects have been exposed to a wide variety of resources. Most college leaders in the locations visited have recognized the value of a combination of techniques and the influence of increased motivation as a result of faculty concern for their success. The manner in which these special resources are delivered to students may have either positive or negative influences on their desire to learn.

While the techniques described in this document have been directed primarily to minority students on historically black compuses, they are fully applicable on any campus. Pertinent workshops and seminars conducted by the Southern Regional Education Board in various parts of the South have

been well attended by faculty from historically white institutions. Notwithstanding, this work has special significance for the historically black institutions as a means of increasing the number of students enrolled in fields of specialization, such as mathematics, the sciences, and engineering, in which they are underrepresented regionally and nationally.

BIBLIOGRAPHY

Armsey, James W., and Dahl, Norman C. An Inquiry into the Uses of Instructional Technology, A Ford Foundation report. New York: The Ford Foundation, 1973.

Atkinson, R.C., and Wilson, H. A., eds. Computer-Assisted Instruction: A Book of Readings. New York: Academic Press, 1969.

Bushnell, Donald D., and Allen, Dwight W. The Computer in American Education, Commissioned by the Association for Educational Data Systems. New York: John Wiley and Sons, Inc., 1967.

Carmichael, J. W., Jr.; Ryan, Mary A. ; and Bauer, JoAnne. General Chemistry Handbook. Champaign, Illinois: Stipes Publishing Co., 1980.

Carmichael, J. W., Jr.; Ryan, Mary A. ; and Whimbey, Arthur. "Cognitive Skills Oriented PSI in General Chemistry," Journal of Developmental and Remedial Education 3 (Winter 1979): 4-6

Center for Curriculum. Computer-Based Curriculum Planning. Amherst: State University of New York at Buffalo, 1976.

Congreve, Willard J. "Learning Center. . .Catalyst for Change!" Educational Leadership XXI (January 1974): 211-16.

Diamond, Robert M. Instructional Development for Individualized Learning in Higher Education. Englewood Cliffs, New Jersey: Educational Technology Publications, 1975.

Dyer, Charles A. Preparing for Computer-Assisted Instruction. Englewood Cliffs, New Jersey: Educational Technology Publications, 1972.

Evans, Richard I. Jean Piaget: The Man and His Ideas. New York: E. P. Dutton and Co., Inc., 1973.

Fisk, Lori, and Lindgren, Henry C. Learning Centers. Glen Ridge, New Jersey: Exceptional Press, 1974.

Gerald, R. W., ed. Computers and Education. New York: McGraw-Hill, 1967.

Groper, George L. Instructional Strategies. Englewood Cliffs, New Jersey: Educational Technology Publications, 1974.

Hawkes, N. The Computer Revolution. Englewood Cliffs, New Jersey: Educational Technology Publications, 1974.

Hicks, B., and Hunka, S. M. The Teacher and The Computer. Philadelphia: W. B. Sanders Co., 1972.

Hill, Joseph E. Cognitive Style as an Educational Science. Oakland Community College: Oakland Community College Press, 1973.

Hirschbuhl, John J. "Hardware Considerations for Computer Based Education in the 1980s," Journal of Research and Development in Education 14 (Fall 1980): 54-55.

Lecarme, O. and Lewis R., eds. Computers in Education. New York: American Elsenier, 1975.

Pruitt, Anne S. New Students and Coordinated Counseling. Atlanta: Southern Regional Education Board, 1973.

Ripple, Richard, and Rockcastle, V. N., eds. Piaget Rediscovered. Ithaca: Cornell University Press, 1973.

Teachey, William G., and Carter, Joseph B. Learning Laboratories: A Guide to Their Adoption and Use. Englewood Cliffs, New Jersey: Education Technology Publications, 1971.

Whimbey, Arthur Intelligence Can Be Taught. New York: E. P. Dutton and Co., Inc., 1975.

Whimbey, Arthur "Teaching Sequential Thought: The Cognitive-Skills Approach," Phi Delta Kappan 58 (December 1977): 255-57.

Whimbey, Arthur, and Lochhead, Jack Problem-Solving and Comprehension: A Short Course in Analytical Reasoning. Philadelphia: Franklin Institute Press, 1980.